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PITTSBURGH PLATE IMPROVEMENTS AT CRYSTAL CITY

New raw material storage and batch preparation plant exhibits interesting and well-planned use of materials-handling equipment. Mixed batch handled on tramrail system with unit containers. Dust control accomplished with enclosed equipment, in combination with evacuation and collector system.

Large deposits of good glass sand near Crystal City, Missouri, have made this small town, situated about 35 miles south of St. Louis, a glass-manufacturing center since early times. For many years, an important plate glass production unit of the Pittsburgh Plate Glass Co. has been located here and has grown into what is today one of the largest and best-equipped plants of its type. Quite naturally, the evolution of this plant has been attended by an almost continuous series of enlargement and improvement programs, the latest of which included the construction of a completely new batch house and handling system. The work was started about two years ago; the new batch plant was put into operation last year, and from the very first it has functioned satisfactorily. THE GLASS INDUSTRY is now privileged to acquaint its readers with the details of this outstanding development.

A general view of the batch storage and preparation plant is shown in Fig. 1. The two-story building in the foreground provides storage for minor batch ingredients, such as arsenic, rouge, powdered coal, etc., the six circular bins, or silos, being used for the bulk materials. Beyond the silos is the structure housing the mixing equipment, and the elevated gallery leading from the mixing house to the factory can be seen at the extreme right. Weighing and gathering equipment is located in a gallery beneath the silos at ground level. Each side of the house is served by a railroad siding, suitable shelters being provided at the unloading stations. The cullet processing and handling equipment is located on the other side of the batch storage house and does not appear in this view.

The first two silos contain soda ash; the third is divided by a vertical partition into two sections, holding salt cake and dolomite, respectively; the fourth encloses a small circular steel bin for feldspar, the remainder of the space being used for lime. The fifth silo accommodates sand and the sixth, cullet. The latter is also divided by a vertical partition into two sections, holding white and green cullet, respectively. All of the silos are of reinforced concrete with a diameter of 28 feet and a depth of 36½ feet.

Raw Materials Handling

Barrels and bags of the minor ingredients are conveyed into the storage building by means of a swinging-tray elevator which has a speed of 50 ft. per min. and will deliver one package every 30 seconds. All of the bulk ingredients except sand and cullet are handled by the elevators shown in Fig. 1, and closer views of the upper works of these elevators are given in Figs. 2 and 3. Both elevators are of the belt type with Z-metal buckets and have capacities of 30 tons per hr. at a speed of 280 ft. per min. Materials are unloaded from the cars into the elevator hoppers by automatic power shovels.

The soda-ash elevator, Fig. 2, is built on 86-ft. centers

Fig. 1. New batch plant of the Pittsburgh Plate Glass Co. at Crystal City, Mo. Storage house for minor constituents in the foreground with six silos for bulk materials and the mixing house in the background.

Fig. 2. Top of soda ash elevator and chutes leading to first two bins. The ladder in the foreground is in the opening of the salt cake silo.

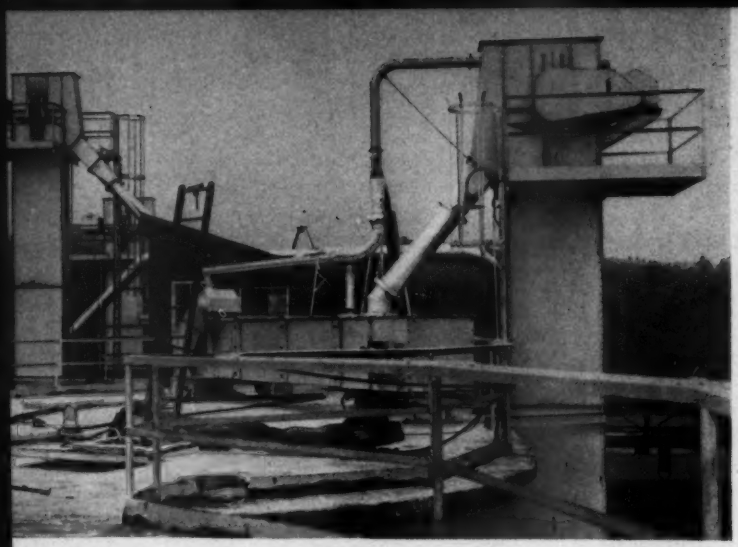

Fig. 3. At right, top of elevator for salt cake, dolomite, feldspar and limestone, with swinging conveyor that discharges to either of four bins. At left, top of sand elevator discharging through chutes to vibrating screens in house above sand bin. Cullet elevator beyond screen house.

Fig. 4. Nearer view of cullet elevator head and horizontal magnetic belt conveyor that discharges to either half of cullet bin through the swinging spout. Green cullet is stored in one-half of the bin and white cullet in the other.

and discharges into either of the first two silos through a bifurcated chute. The other elevator on this side of the building is on 72-ft. centers and discharges into the third and fourth silos, but these silos are arranged to hold four different materials, as previously described. The distribution of the proper material to the proper bin is accomplished by means of a 24-in. shuttle belt conveyor, one end of which pivots on a fixed bearing while the other end swings around on a circular supporting rail. The top of the elevator, with its discharge chute and the swinging conveyor, is shown at the right in Fig. 3. This system handles salt cake, dolomite, feldspar and limestone.

Sand is mined on company property, the mine being located on rising ground between the plant and the Mississippi River. These hills appear in the background of Fig. 3. From the mine the sand is transported in box cars to the batch house where it is discharged through four inlet boxes to an 18-in. belt conveyor, the conveyor having a dust-tight housing with removable inspection and cleaning doors at convenient intervals. The short conveyor delivers the sand to an elevator which has 82-ft. centers and handles 50 tons per hr. at 280 ft. per min. The top of this elevator is shown at the extreme left in Fig. 3. It discharges through a bifurcated chute to a couple of vibrating screens which are located in a small screen house on top of the sand silo in front of the elevator head. The screened sand is discharged directly into the silo.

Cullet System

The cullet system is arranged to handle both foreign and factory cullet and has several unusual features. Factory cullet is carried by an elevator into the cullet washer, from which it is dumped into a hopper and fed to a 20-in. inclined pan conveyor discharging into the cullet crusher. At the same time foreign cullet can be unloaded from cars into a track hopper above the crusher and either passed into the crusher, from which it is discharged through rack-and-pinion gates to a second inclined pan conveyor, or it may be by-passed around the crusher through an auxiliary chute to the same conveyor. The pan conveyors carrying uncrushed and crushed cullet have capacities of 10 tons per hr. and 30 tons per hr., respectively, at a speed of 29 ft. per min., and are completely enclosed in dust-tight housings.

From the second pan conveyor the cullet passes through a counter-weighted regulating gate to the storage bin elevator which discharges through a revolving-vane feeder at the top of the silo on a 24-in. magnetic belt conveyor. The top of the cullet elevator appears beyond the sand screen house in Fig. 3 and a closer view of the cullet system on top of the silo is shown in Fig. 4. The magnetic head pulley is located in the right-hand end of the horizontal conveyor housing, just above the two-way chute through which the cullet may be discharged into either section of the silo. As stated before, green cullet is stored in one section and white cullet in the other. The cullet elevator has a capacity of 30 tons per hr. and is of the same belt-type construction, with Z-metal buckets, as the others.

Batch Weighing Equipment

The raw batch materials from the storage silos are fed into weigh hoppers through manually-controlled, undercut bin gates. Fig. 5 shows one of the weigh hoppers hanging on the scale beams above the enclosed gathering belt conveyor, together with the dial scale at the left. The long operating lever for the bin gate appears at the left also, just in front of the scale, a connection being made near the top end of the lever with an electric interlock encased in a rectangular metal box. Another interlock is tied into the manually-operated gate at the bottom of the weigh hopper, so that both gates cannot be open at the same time. Each weigh hopper is equipped with an auxiliary chute and a slide gate through which the operator can draw off small amounts of material to secure exact weight. This excess material passes into an open box, which rests on top of the conveyor housing

in front of the hopper gate, and is thereafter used for makeup purposes when the amount drawn from the storage bin is slightly less than required.

The weighing system includes a total of ten weigh hoppers and scales, nine of which handle materials from the silos. The tenth is a small unit at the far end of the line for weighing rouge, powdered coal and arsenic, this scale being manually loaded from suitable portable containers. Fig. 6 is a view looking down the gallery at one side of the collecting conveyor and shows the weigh hoppers above the conveyor housing with the scales across the aisle. The scales are of the springless type. The delivery end of the conveyor is in the foreground and, as one passes down the aisle, the following arrangement of hoppers and scales is seen:

Material	*Hopper Capacity in cu. ft.*	*Scale Capacity in lb.*
Green cullet	30	2,000
White cullet	30	2,000
Sand	30	3,000
Limestone	15	1,000
Feldspar	5	500
Dolomite	15	1,000
Salt cake	5	500
Soda ash	15	1,000
Soda ash	15	1,000
Rouge, arsenic, coal	Pan	60

The horizontal gathering belt is 185 ft. long and is of the troughed-belt type, 24 in. wide. Its dust-tight housing has removable panels for inspection, no tools being required, and the conveyor will handle 50 tons per hr. at 90 lb. per cu. ft. At the head pulley end the conveyor discharges into the batch mix elevator, the lower end of the elevator housing appearing at the right in Fig. 6. A revolving brush at the head pulley cleans the belt before its return run. The belt-type elevator, with Z-metal buckets, has 52-ft. centers and a capacity of 50 tons per hr. at 280 ft. per min.

Mixing Building Equipment and Controls

At the top of the mixing house the elevator discharges into a storage bin, the lower section of which is shown in Fig. 7. This bin has a storage capacity of 75 cu. ft. and is provided with a Bindicator near the bottom to show when the bin is empty. The undercut gate at the bottom of the bin is motor-operated and is fitted with limit switches which control indicator lights near the operator's station on the ground floor. The indicators are shown near the top in Fig. 6. The left-hand indicator has a white light, reads "Bin Empty," and is controlled by the Bindicator. The middle one has a green light and reads "Gate Closed," the third having a red light and reading "Gate Open." The latter two are controlled, of course, by the limit switches on the bin gate.

From the storage bin the unmixed batch is delivered to the Rex No. 6 dust-tight mixer. The total weight of each batch is about 3,600 lb. and at Crystal City about 9 gal. of water are added to the batch during the mixing operation. A water holder with the proper capacity is mounted above the mixer and can be seen at the lower right in Fig. 7. Through a meter at the operator's station the proper amount of water is admitted to the container and is then released into the mixer at the right time dur-

Fig. 5. Typical weighing unit for raw material, including hopper and scale. Long vertical lever at left operates bin gate and the hopper gate lever is on the side toward the scale. Electric interlocks for bin and hopper gates are housed in rectangular boxes at upper left and right center.

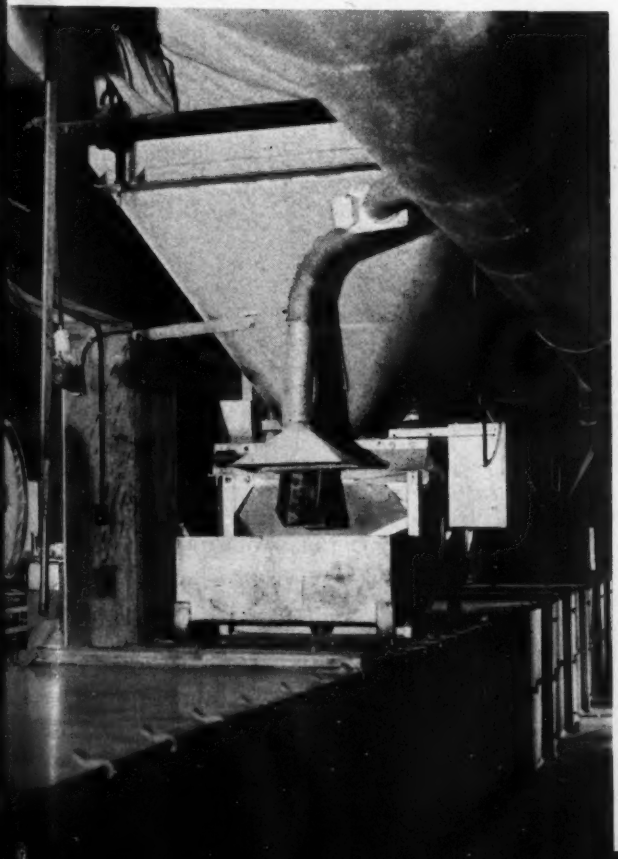

Fig. 6. Looking down the weigh gallery from the operator's position. Scales are at left with weigh hoppers opposite; gathering belt in housing on floor delivers to elevator at right. Conditions in storage bin at top of mixing house are shown by signals above the aisle.

Fig. 7. Lower portion of batch storage bin above mixer, showing bin gate limit switches, together with water container for moistening batch at the lower right.

Fig. 8. Right: Lower portion of mixed batch bin with rotary feeder discharging to magnetic conveyor.

ing the mixing operation. The unloading dipper of the mixer is manually operated from the ground floor and white and red lights indicate whether the mixer dipper is "out" or "in," respectively.

With the mixer dipper "in," the contents of the mixer are discharged into the mixed batch bin, the lower section of which can be seen at the top in Fig. 8. Here the batch is held until a couple of unit batch containers are in position at the loading station on the ground floor, at which time a rotary feeder delivers the mixed batch to a magnetic belt conveyor and this conveyor, in turn, discharges into the unit containers through two chutes. The loading station is shown in Fig. 9, with the rectangular chutes leading down from the end of the magnetic conveyor above.

Empty batch buckets are placed on a steel-platform conveyor at the ground-floor level, this conveyor carrying them into the loading enclosure and holding them during the loading operation. The filled buckets pass out at the other end of the enclosure on the conveyor and are then lifted and transported either directly to the tank or to the storage space in the gallery. The platform conveyor is 4 ft. wide with 36-ft. sprocket centers, the flights being made up of 8-in. channels. It has an all-welded frame with removable rail and track angles.

All of the materials-handling and mixing equipment so far described was furnished on specifications worked out by the engineering department of the Pittsburgh Plate Glass Co. The system is not fully automatic in operation, but the few manual controls and operations are such that the entire job of weighing, mixing and delivering to the buckets can be done by one operator. Certain vital parts of the system are interlocked to insure proper sequence of operation, and automatic signals indicate to the operator what is going on in the mixing building.

Procedure for Batch Preparation

The operator's control station is on the ground floor of the mixing house between the elevator and the bucket loading station, the view in Fig. 6 being made from his position. On the wall to the right of the doorway in Fig. 9 are six push-button stations for controlling motors in various parts of the system, arranged as follows: 1, Bucket conveyor (Platform); 2, Bucket loading conveyor (Magnetic belt); 3, Batch mixer; 4, Bin gate; 5, Batch elevator; 6, Batch gathering conveyor.

In regular operation the motors controlled by Nos. 2, 3, 5 and 6 run continuously, but Nos. 2, 5 and 6 are so interlocked that there will be no pile-up in the system if one motor is stopped. For instance, if No. 6 stops, Nos. 2 and 5 will continue to run; if No. 5 stops, No. 6 will also stop and No. 2 can continue running; but if No. 2 stops, both No. 5 and No. 6 stop immediately and the entire system is at rest.

With the unmixed batch bin empty and its motor-operated gate closed and with all weigh hoppers filled with the proper quantities of materials, the operator proceeds down the gallery and releases the weigh hopper contents, one after the other, to the gathering belt. As each hopper empties and its scale pointer returns to zero, a light above the scale, see Fig. 5, comes on and indicates that the hopper is empty. To insure complete emptying, electric vibrators are provided on the hoppers for cullet, lime, feldspar and salt cake. Then, on his return trip, the operator closes each hopper gate and refills the hopper with the proper weight of material through the manually-operated bin gate. As stated previously, the hopper gate and the bin gate are interlocked so that both can not be opened at the same time. At the end of the round trip the operator will have collected and transferred a complete batch to the storage bin and all ingredients for the next batch will be in the weigh

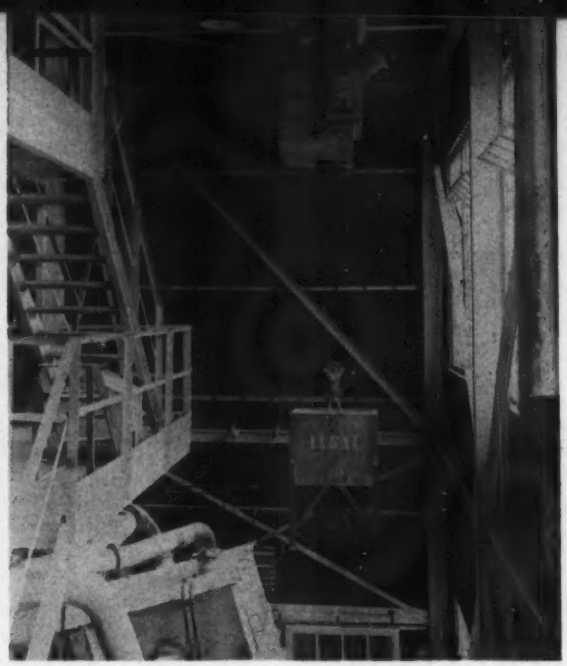

Fig. 9. Left: Batch buckets on platform conveyor are filled through rectangular chutes from the magnetic conveyor. Round pipes exhaust dust from loading enclosure.

Fig. 10. Above: Tramrail hoist raising loaded batch bucket from ground-floor loading station to tank level. Note end of magnetic conveyor housing at lower left.

hoppers. From this point on, the intermittent operations of the storage bin gate, the mixer dipper and the batch bucket conveyor are controlled in accordance with the automatic signals and the required time intervals.

Transportation of Mixed Batch

In its progress from the loading station to the melting tanks the batch bucket is first lifted through the open well at the end of the mixer building and then carried through the long gallery to the tank room. From the center line of the mixing house to the center line of No. 1 tank the distance is 210 ft. and the center line of No. 2 tank is 103 ft. farther along. Fig. 10 shows the loaded bucket being lifted from the loading station, the height from ground floor level to the tramrail being about 33 ft. In this view the delivery end of the magnetic belt conveyor can also be seen in the lower left corner.

Part of the tramrail system was used in connection with the former batch plant. For the new installation the system was extended and changed to suit the new arrangement of buildings and gallery. The high lift requirement does not lend itself to automatic operation, except at considerable complexity and cost, so the hoist operator rides in a glass-enclosed cab attached to the hoist. Neither does this arrangement lend itself to convenient storage of batch buckets on the tramrail, but there is plenty of storage space on the floor of the gallery, as shown in Fig. 11, and the supports for the tramrail do not have to be as heavy and expensive, since only the hoist and one bucket are supported by the rail at any one time.

In Fig. 10 the end of the tramrail in the mixing house can be seen at the top, and this rail extends straight down the center of the gallery, as shown in Fig. 11, and past No. 1 tank. Between the tanks it curves to the right close to the back end of No. 2 tank and then loops around to return through the gallery as the left-hand line shown on the front cover, finally switching into the middle line near the mixing building. The third, or right-hand line, switches off from the middle rail at the same point near the mixing building, passes close to the rear of No. 1 tank and meets the middle line again in a switch between the tanks. Another set of switches is provided between the three rails at the end of the gallery next to the tank room. Fig. 11 shows the hoist with a loaded batch bucket, on its way to No. 1 tank, passing over one of these switches. The switches are thrown by the hoist operator from his cab by means of pull ropes at convenient positions, so he is enabled to traverse the entire system, raise, lower and spot the bucket without aid. Buckets on the hoist are immediately in front of him and can be seen readily through the glass window of the cab.

Fig. 11. Closer view of tramrail hoist passing through switch to tramrail section near the tank.

Fig. 12. Charging the tank. Tramrail hoist (upper left) places loaded bucket on structure above the doughouse and tank operator opens bucket gate with long hook. Note tramrail to gallery and batch house.

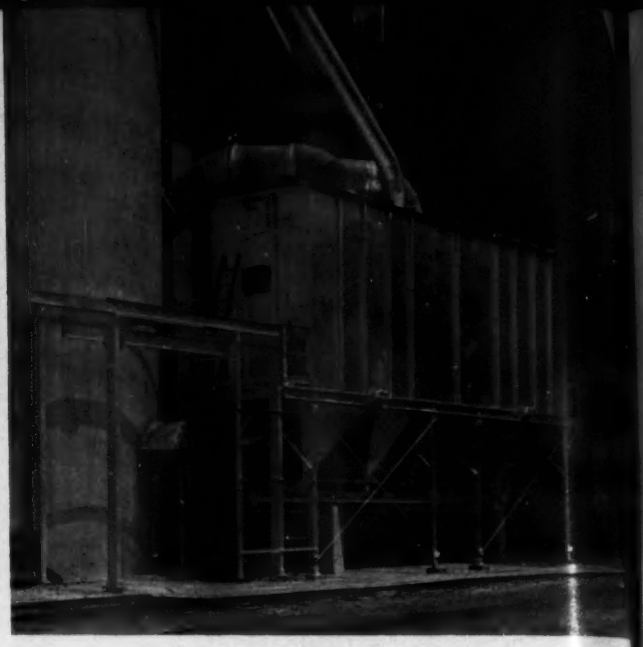

Fig. 13. Dust collecting equipment. Cullet silo at left, mixing crop on left if necessary, building behind collector, and gallery to tank room at upper right.

The hoist frame is carried on two motor-driven, four wheel trucks, current being picked up from trolley wires alongside the tramrail. The cab hangs from its own wheels on the tramrail and is towed around by the hoist. The hoist has a lift of 25 ft., a capacity of 2 tons, and a lifting speed of 40 ft. per min. Both the travel and hoisting motors operate on direct current at 220 volts, the travel speed being 300 ft. per minute.

Fig. 12 is a view in the tank room behind No. 1 tank, showing the position of the tramrail section relative to the tank, and the tank charging mechanism. The hoist operator has picked up a loaded batch bucket, either from the mixing house or the storage space in the gallery, and has switched himself and his load to the tramrail section nearest the tank. The bucket has been spotted and lowered until it rests on a structural framework above the doghouse, this framework also carrying a wide hopper which delivers the batch to the doghouse. As soon as the bucket is in position the tank operator opens the bucket gate with a long hook, as shown, and the batch flows into the hopper. At the proper time the motor-operated pusher, located on the floor in front of the doghouse, is started and the batch is pushed into the furnace. Necessary manipulation of the batch and sealing of the opening is accomplished by means of the usual type of hand tools, which are placed on convenient holders so the operator does not have to stoop and pick them up.

Although practically all of the material-handling equipment in the new batch house is totally enclosed, a complete dust collecting system has been installed to eliminate dust at certain points. The bag-type dust collector can be seen beyond the track shed in Fig. 1 and a closer view is shown in Fig. 13. The equipment is located alongside the mixing building near the cullet silo and the pipes leading from the top, from the weigh gallery and from the mixing building can be seen at the top of the structure. Dust piping from the sand screen house and the elevators at the top of the silos is shown in Fig. 3; the long pipe that runs along the weigh gallery appears at the upper right in Fig. 5, together with the short connections to hoods above the excess-material boxes. The weigh gallery pipe also appears behind the signal lights at the top of Fig. 6, passing through the wall of the building to the collector outside. Fig. 9 shows the dust collector hoods and round exhaust pipes at the bucket loading enclosure.

The major requirements of a good batch plant are accurate proportioning, thorough mixing, prevention of segregation in mixed batch and eliminaton of the dust hazard. In the new Pittsburgh Plate plant at Crystal City a satisfactory accuracy in weighing is secured by providing separate scales for each ingredient and performing the weighing operations in rotation. If one constituent is forgotten the light above that particular scale will be left burning and can be seen by the operator when he returns to the control room. If all the lights are out there must be some material, at least in each weigh hopper and the operator should be able to procure the right amount in each case without trouble. It might be expected that automatic scale control of the filling and emptying of the weigh hoppers would insure additional accuracy in batch proportioning, but the Crystal City system represents an excellent example of proper manual control.

Thorough mixing is, of course, possible through proper timing and the use of a mixer of the right size for the amount of material. The most effective method for the prevention of segregation in the mixed batch is the use of unit containers, or buckets, and this plant is certainly adequate from this standpoint, since the batch is moved from the mixer to the tank with a minimum amount of agitation. Finally, the dust hazard is combatted not only by enclosure of the material-handling equipment, but also by the use of an auxiliary dust collecting system. Just what effect the removal of some of the batch material in the form of dust can have on the batch proportions is not apparent, but at present it cannot be put into the batch on account of the variation in its composition. The quality of the glass produced at Crystal City is uniformly high and for this happy state of affairs the new batch plant must be given credit.

THE ROLE OF GASES IN GLASS: III. WATER

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That water can be present as a constituent of glass, or even that it can play a part in the glass-melting process, is hard to imagine. The likely picture is that all of the water would have gone steaming up the flue in the earliest stages of melting. Yet enough evidence has now been accumulated to prove that important amounts of water remain in commercial glasses.[1] Some evidence has been published relating to the influence of this water on the properties and melting of the glass, the large-scale experiments of W. E. S. Turner being particularly enlightening. But researches in this field have always seemed to lead up a blind alley because such contradictory results were obtained.

Much of the confusion can be attributed to incomplete visualization of the different ways in which water can be introduced during glass-melting and of the factors affecting its rate of removal from the melt. It may be well to begin by reviewing some of the elementary facts about the reactions of water during heating.

Sources of Water

Water can be introduced into a glass melt either from the furnace atmosphere or through the batch materials. In the furnace atmosphere the water vapor may have been derived from the batch, from atmospheric humidity, or from the combustion of the fuel. In the batch the H_2O may be conveniently classified into "liquid water" and "chemically combined water." The former should, in general, volatilize by 300° C., while the latter may be retained in the crystals and the melt to much higher temperatures, in some cases above 1000° C. In practice their temperatures and rates of evolution are considerably slowed by the kinetics of the diffusion of heat into the batch and of the transportation of the water into the vapor phase. The pressure of the furnace atmosphere and its partial pressure for water also affect the rate of volatilization.

The temperature at which the water is released from the batch materials depends upon the strength of the forces restraining it from vaporization. Some of the liquid water molecules in contact only with other water molecules boil easily at 100° C. Other portions of the liquid water may be held more or less firmly in the capillaries on the surfaces of the solid grains and are vaporized only with difficulty at several hundred degrees. Even though it is within and a part of the molecule, water of crystallization from such substances as $Na_2CO_3.10H_2O$ is given off easily around 100° C. Other substances retain part of their chemically combined water to high temperatures and can be freed of the last traces only when extreme measures are taken. In chemical analysis for aluminium oxide, for example, the hydroxide has to be blasted for a protracted time before it will reach a sufficiently constant weight. The difficulties in removing the last traces of water from molten B_2O_3 are also well-known.

For water to be retained in a melt at the high temperatures of melting and fining, some material, like alumina or boric oxide, which can hold on to it tenaciously at 1000-1400° C., should be present. The phenomenon resembles the oxygen balance mechanism described in the first paper of this series. There it was pointed out that the optimum amount of niter in a batch depends upon its ratio to the arsenic or antimony content. Oxygen introduced in the presence of niter alone will be quantitatively removed during the evolution of carbon dioxide. If an excess of the gas is to be retained in the melt for utilization during fining, it is essential that a compound like arsenic be present to store the oxygen until the fining range is reached. Similarly, the chances are that water can only be retained in a glass if it can go into a chemical combination with some ingredient. Even if this ingredient enters the melt from a source in which it does not contain chemically combined water (alumina from feldspar or from refractory attack), it should store water which comes into its neighborhood during the steaming period at the early stages of melting.

Some of the contradictions in the observations on the effects of water on the properties of molten glass can be traced to neglect of these simple facts. Melting a glass in a platinum crucible in an electric furnace comes pretty near to melting in a vacuum so far as the H_2O concentration is concerned. Such an experimental melt can not reasonably be compared with a melting on a technical scale where the H_2O concentration in the furnace atmosphere retards complete loss of the water from the glass. We should emphasize the fact that, as in the case of the oxygen balance, not the amount of water put in with the batch affects the properties, but the amount which can be kept through the fining period.

Reactions of Water during Glass Melting

Water participates in the melting process in a number of capacities. First, the vaporization of the liquid water takes place at a low temperature. If thoroughly dried batch materials are not used, the rate of melting should be slowed because the high heat of vaporization of water leads to its stealing much of the heat which should be used for raising the temperature of the batch materials. Water is a very effective absorber of infrared radiations, and the presence of steam in the furnace atmosphere will further retard the transfer of radiant heat to the melt.

During the next stage of glass-melting—solid phase reactions between the carbonates and silica—water can also play the controlling role. In fact scientists debated for years whether solid phase reactions can take place at all in the complete absence of traces of water. It is now generally accepted that true solid phase reactions do occur, but the presence of traces of water enormously accelerates them. A picture of the effect of water at this stage has been presented by Jebsen-Marwedel. He assumes that each grain of silica is covered by a film of adsorbed water which, due to its solvent power, grad-

ually changes into a concentrated solution of sodium carbonate capable of relatively rapid reaction with the SiO_2. Striking evidence for this beneficial effect of water can be obtained with the fluorescence method described in the first paper. If a cake is pressed from a dry glass batch containing a few per cent of sodium uranate, the temperature at which glass formation first takes place is revealed by the beginning of fluorescence. Drops of water on such batch cakes show clearly by the earlier and stronger fluorescence in the region around the drop that this part of the cake is much richer in glass than is the average.

With the voluminous evolution of carbon dioxide which results from solid phase and liquid reactions, the furnace atmosphere is reduced to a very low partial pressure of H_2O and most of the remaining water is swept out of the melting mass. From now on the water content of the furnace atmosphere controls the amount of water in the glass.

With the reaching of the melting stage the role of water now becomes that of a fining agent. Analysis of gas bubbles from samples taken at different times of melting has shown that a rather high percentage of water is contained in samples from the early stages. In pot melting it is an old practice to use water-containing materials for "blocking," and there is no doubt that the suddenly vaporized water has a fining, as well as a stirring, action. An explanation of the fining action of water is that, as first formed, the bubbles are primarily steam and have very low partial pressures of carbon dioxide or sulphur dioxide. Therefore they exert a strong sucking action on the CO_2 and SO_2 dissolved in the melt, in the way described in the first paper. As pointed out there, the more gases there are present in a bubble, the lower the partial pressures of the individual gases, and the more effective its fining action.

Another function of water at this stage is as a reactant. Very little is known about the behavior of water at high temperatures, but Arrhenius made the rough extrapolation that though silicic acid is 100 times stronger than water at room temperature, at 300°C water acts as an acid of about the same strength as silicic acid, and by 1000° C the original ratio is reversed and the silicic acid possesses only one hundredth the strength of water as an acid. Although this is only a rough extrapolation, it indicates that we have to deal at high temperatures with a strong competitor for reaction with alkali ions and for binding into the structure of the fluid or the cooled glass. But for any important position in the structure, it is necessary that large amounts of water remain and this can be brought about only under extraordinary conditions. C. Barus and G. W. Morey, for example, heated glasses and other silicate combinations under high H_2O pressure in autoclaves and obtained glasses with as much as 25 per cent H_2O.

Effects of Water on the Properties of Glass

However, minute proportions of water can have an important effect on the formation and properties of glasses by functioning as "mineralizers." It has been found that some magmas form crystalline rocks, whereas others of nearly the same chemical composition form glasses (obsidians, etc.) on cooling. The only difference between two such magmas is the presence of certain minor constituents as water, hydrofluoric acid, hydrochloric acid, and boron compounds. Such constituents, which in small amounts cause crystallization of a magma, are called "mineralizers." They usually increase the fluidity of a silicate melt at high temperatures by breaking down certain aggregates into smaller units. As the tendency to form highly associated units seems to lead to the formation of a glassy state, the effect of mineralizers is not limited to silicates. Small amounts of iodine, for instance, decrease the viscosity of molten sulphur enormously. Organic glasses similarly increase the number of crystallization nuclei when small amounts of certain substances are added.

Mineralizers, then, can be defined as substances which cause changes in the properties of glasses which cannot be expected from their relatively low concentrations, and can be attributed to the fact that the association-dissociation relationships of the main glass-forming agents are changed considerably. The important effects of such associations on the physical properties of glasses has been demonstrated by numerous studies on the effect of heat treatment on such properties as density and index of refraction.

Because the viscosity is very sensitive to constitutional changes, the effect of mineralizers has been observed on this property first. As a matter of course, all properties will be affected, for the properties of a glass depend on the degree of association-dissociation. Even when the viscosity reaches values too high to permit differentiation between dry glasses and water-containing glasses, we may still expect differences in other properties. There is only one paper we know of which offers exact data on such effects from the presence of water in glasses. Wulff and Majumdar were studying the densities and refractive indices of borate glasses and found that if the glasses were melted under vacuum the density values became lower than under ordinary conditions. The effect is attributed to the strong forces exerted by the proton, that is the hydrogen ion.

Since the density of a glass is not as sensitive as the viscosity, density changes have only been verified for borate glasses so far. We have already pointed out that boric oxide is especially prone to keep back water, and so we cannot expect that the changes in silicate glasses would be of the same order of magnitude.

So, work on this particular problem is still needed. There are papers and patents claiming improved strength, chemical durability, etc., with increased water content in glass, but it is very difficult to decide whether this change is to be attributed to the water present causing a constitutional change, or to some other factor. It seems rather probable that the fining effect and the lowering of the viscosity by increasing the homogeneity of a glass melt accounts for the improvements in strength, appearance, rate of melting, and chemical durability.

It is also possible that constitutional changes may form the main reason for observed changes in properties. At very high temperatures the effect of water can be explained by the assumption that the electric field of the introduced proton breaks associated silica groups into smaller units. With decreasing temperature, however, we have to expect that the hydrogen ion or the proton may act as a center of forces in attracting and orienting

present groupings and thus contributing to a steeper increase in the viscosity-temperature curve and an increase in the density and refractive values. Very similar effects have been observed in the field of aqueous and non-aqueous solutions.

Determination of Water in Glass

The amount of water in glass may be determined by the analysis of the gases evolved on melting in a vacuum furnace. With bubbles the method of Enss described in Part II[2] may be used. Both of these are slow and difficult, however, and it would be interesting to follow up the question which was raised by E. D. Tillyer at the 1935 meeting of the American Ceramic Society. During a discussion of the infra-red transmission of glass, he pointed out that the presence of B_2O_3 in glass causes a marked decrease in transmission in the 3.5 micron region. The infra-red transmission curve of water also shows a dip at this point, and Tillyer left it open to future evidence as to whether this paricular absorption band in glass is caused by the boric oxide or by water.

Applications

An interesting phenomenon, which clearly indicates the fact that glasses contain more or less water, has been observed by B. Long. He found that borosilicate glasses containing titania which have been melted under reducing conditions yield dark glasses which blow up and form a foam when cooled very slowly or when submitted to a special heat treatment. The same phenomenon has been observed by W. Weyl in the case of chromium glass and the explanation has been given that under strong reducing conditions chromium and titanium oxides may form lower oxides at high temperatures. With decreasing temperature these lower oxides become more and more unstable and show a strong tendency to oxidize to the higher forms. If the glass contains water or residual carbon dioxide, the lower oxide reduces these gases to hydrogen or carbon monoxide. As both of these gases are insoluble in glass, their liberation causes the formation of a foam. Wide applications of these "foam glasses" has been predicted wherever a light cellular material is needed, for heat and sound insulation, aggregate in concrete, and so on.

Barus had observed that the high water glass which he made swelled on heating and formed a pumice-like mass. Advantage is taken of this phenomenon in a German process for manufacture of an artificial pumice for abrasive purposes. Volcanic glass, obsidian, preheated to 900° C., is dropped down a shaft furnace against a rising draft of hot gases. The obsidian swells into porous particles with a lower apparent specific gravity than natural pumice.

[1]See Table in Part I of this series, *Glass Industry*, July, 1938, Vol. 19, Page 255.

[2]*The Glass Industry*, September, 1938, Vol. 19, page 347.

1938 CHEMICAL ENGINEERING CATALOG

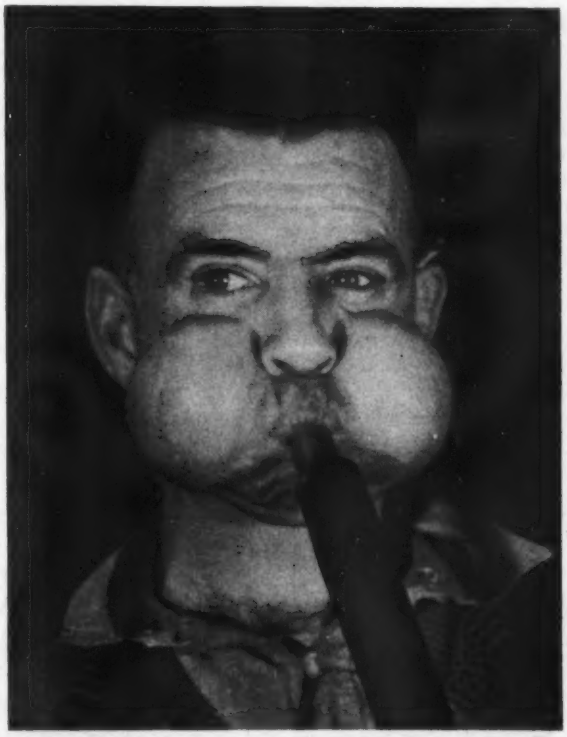
The 23rd Annual (1938) edition of The Chemical Engineering Catalog has been published. It is a catalog of manufacturing equipment, chemicals, raw materials, and technical books. It will be useful to the plant official, the engineer, as well as to the men in charge of chemical development work.

SHAWINIGAN ADDS TO PLANT

Shawinigan Resins Corporation, Springfield, Mass., jointly owned by Shawinigan Chemicals, Ltd., and Fiberoid Corporation, is planning additions to its plant and equipment that will result in production being more than doubled and also enable the corporation to increase the number of its lines. In view of the prospective demand for the corporation's line of vinyl acetal resins, the group of plastics developed for the production of stronger safety glass and related products, it is proposed to increase the plant's output from its present two tons of resins per day to approximately five tons per day. When current expansion plans are completed the Shawinigan Resins Corp. will be producing ten to twelve thousand pounds per day, or sufficient resin to fabricate about 50 million square feet of safety glass plastic per year. This is said to represent about half the current requirements of glass manufacturers.

ROMANCE OF SANDWICH GLASS

Glass collectors will hail with interest the announcement that a second printing of "The Romance of Old Sandwich Glass" by Frank W. Chipman was published October 1. It is a well-told, authentic story, covering the romantic history of old Sandwich and including a Dictionary of Old Sandwich Glass Patterns. The book is profusely illustrated, many of the illustrations showing glass from famous collections. It contains much other authentic information helpful to the collector, such as the author's advice on "How to tell Old Sandwich."



●Movietone News writes, "This is what happens to you if you happen to be a glass blower. Bill Hensel has been blowing glass for a Sydney, N.S.W., glass factory for 20 years. He might qualify as a saxophone player in a swing 'band.'"

MODERN LEHR SHIPPED IN SECTIONS

One of the advantages of the modern type of lehr with its steel-frame construction is shown in the accompanying illustration. This design permits the complete fabrication and assembly of the entire casing in the manufacturer's plant, thus making possible a much greater degree of accuracy in alignment. There is probably a considerable saving in assembly cost to both user and manufacturer also, since the job can be done with much greater efficiency in the manufacturing plant than in the field.

The decorating lehr shown ready for shipment was assembled in the plant of the Surface Combustion Co., Toledo, and then divided into two sections for shipment on flat cars. It is ready for a trip to Mexico where it will be used for decorating bottles by the Solar process. The lehr has an effective belt width of 48 in. and is 75 ft. long.

PRODUCTION FIGURES FOR THE GLASS INDUSTRY DURING SEPTEMBER

Glass Containers: Production of glass containers during the month of September, 1938, was 3,652,909 gross, bringing the 1938 total to 32,007,580 gross. Shipments during September were 3,970,798 gross, bringing the 1938 total to 32,890,823 gross.

Plate glass: The production of polished plate glass by member companies of the Plate Glass Manufacturers of America during September, 1938, was 8,873,344 sq. ft. as compared to 7,767,078 sq. ft. produced in the preceding month, August, and 16,479,144 sq. ft. produced in the corresponding month last year, September 1937.

This makes a total of 47,282,492 sq. ft. produced during the first nine months of 1938.

Window glass: During September, 1938, the production of window glass was 522,145 boxes, which represents 32.1 per cent of industry capacity. As compared with this, September 1937 production was 1,212,374 boxes representing 74.7 per cent of industry capacity.

MICHAEL SWEENEY'S MONUMENT

Illustrated here is an unusual monument marking the grave of a glass making pioneer. The monument itself is unique, for enclosed in it is a sample of glassware made in Wheeling, W. Va., many years ago. The urn, or vase inside the monument, won a grand prize in the World Exposition, Paris, France, 1851. A duplicate is now in the British Museum, London. A third bowl, exactly the same was presented to Henry Clay.

Michael Sweeney came to this country when a small boy. In young manhood, he learned the glass trade. In the late 1840's, he founded a small glass making factory. the T. Sweeney Glass Manufacturing Co., in Wheeling, with his brother, Thomas. During his spare time, Michael made the moulds by hand for the bowl shown inside the monument. He experimented and dabbled with the pattern but it was too large and awkward. After several attempts, he finally cast the three urns, which were "flawless." His brother admitted they were good. But when Michael dreamed of entering the Paris Exposition, the brothers quarreled. Michael moved across the Ohio river in 1850 to Martins Ferry, and founded another company. It was the M. Sweeney & Co. In 1863 it was reorganized and became the Sweeney, Bell, McCluney & Co. In 1868, Thomas Sweeney retired, and his brother moved the first plant to Martins Ferry where it prospered for years. Then fire destroyed the plant.

The story of the trip of the urn to the Paris Exposition is recalled by descendants of glass pioneers. It was carefully packed and crated and shipped to Pittsburgh by boat . . . cross country by devious means and finally shipped abroad from Baltimore. It was called "Sweeney's folly" . . . but when the awarding of the grand prix came, he was a hero. The urn in the British Museum was his gift to posterity . . . And he made all plans for enclosing the prize winner in his grave marker before he died. The monument is marble . . . it is airtight . . . and attracts but little attention from the local folks who do not know its history.—*R. R. Maguire.*

DUNBAR GLASS USES NOVEL LEHR FOR OVEN WARE

New equipment marks the first application of a recently-developed heating apparatus of unusual construction. Heat zone condition has some characteristics of both closed-muffle and open-fired types.

The Dunbar Glass Corporation, Dunbar, W. Va., has long manufactured a notable and varied line of plain and decorated hand-blown and pressed table ware, together with specialties in crystal and colored glasses. When a line of heat-resisting oven ware was added, the problem of annealing at a higher temperature was faced and the lehr which was selected and installed is of quite general interest, because it represents a considerable departure from accepted design and operation. The new lehr was furnished by the Toledo Engineering Co., Inc., of Toledo, and is known as the "Firoll" type, its most unusual feature being a novel construction and arrangement of heating apparatus.

For annealing heat-resisting ware at a commercial rate it is important that the heating zone be held at uniform temperature over the entire width, without hot or cold spots. Of value, also, is some means of controlling the length of the heating zone to suit annealing requirements under varied conditions. Both of these factors are considered in the "Firoll" heating arrangements, which at the same time produce a slight pressure in the lehr without the use of circulating fans. Fig. 1 shows an outside view of the new lehr, looking at the charging end.

The specific feature of the new Dunbar lehr which distinguishes it from other types is an ingenious method of burning the fuel inside the hollow rollers that carry the lehr belt, and ejecting a small portion of the products of combustion at the flared ends of the rollers to heat the inside walls of the lehr tunnel. The ejection of these combustion products produces the slight pressure inside the lehr, referred to above. The arrangement of the burners and the belt rollers is shown diagrammatically in Fig. 2. Automatically controlled master valves deliver combustion air and natural gas to pipes A and B, respectively, combustion taking place at the end of the burner pipe, just inside the lehr wall. The burner protrudes a short distance into the flared end of the hollow roller D, the latter being supported by two pairs of trunnion wheels and free to rotate on its axis.

At the other end of the tubular roller an exhaust pipe also projects a short distance into the flared end, this pipe leading to an air inductor which is supplied with low pressure air through the pipe C. The greatly diluted and cooled combustion products are dissipated by the vertical pipe above the inductor into the atmosphere above the lehr. The exhaust pipe is lagged with insulating material to prevent personal injury from contact. It is apparent that the control of the combustion action inside the tube is very versatile. By means of a proper balance between the burner input and the induced exhaust, the tube can be heated quite uniformly throughout its entire length and small convection currents of combustion products can be made to emerge from the flared ends of the tube close to the side walls. When the proper burner-exhaust balance has been secured, the master valves for combustion air, fuel gas and inductor air are automatically controlled from the indicating pyrometer, and the required annealing temperature is automatically maintained.

Further means for insuring uniform heating over the entire width of the lehr belt is shown in the diagrammatic longitudinal section, Fig 3. Since the burner end of each tube is sure to be slightly hotter than the remainder, alternate rollers are fired from opposite sides of the lehr, the net result being a uniformly high temperature throughout the heating zone. As indicated,

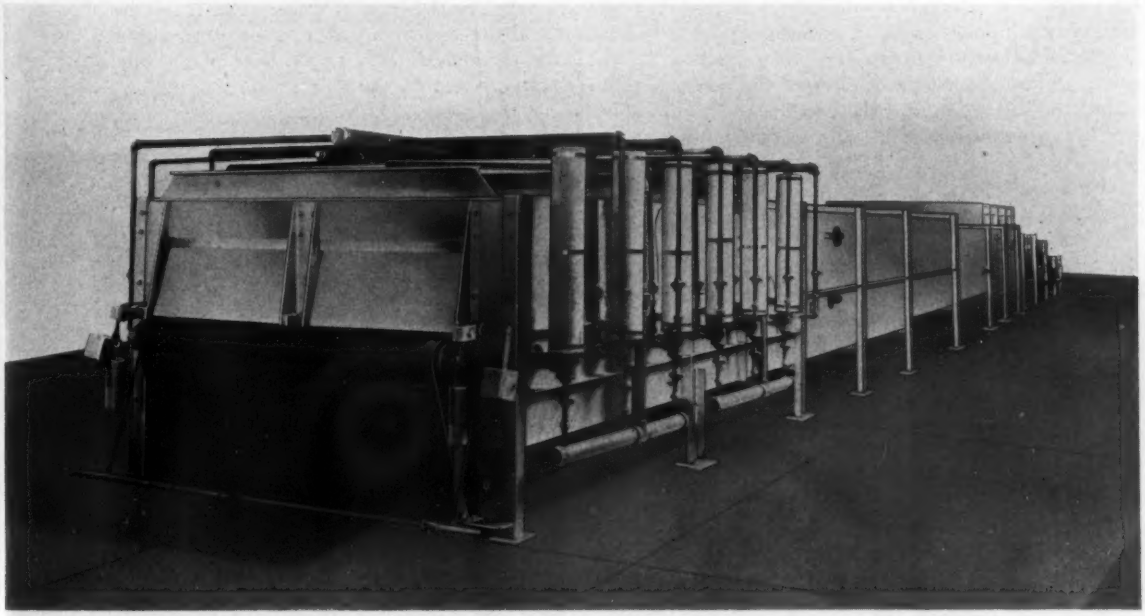


Fig. 1. View toward the charging end of the new "Firoll" lehr recently installed by the Dunbar Glass Corp. for annealing oven ware.

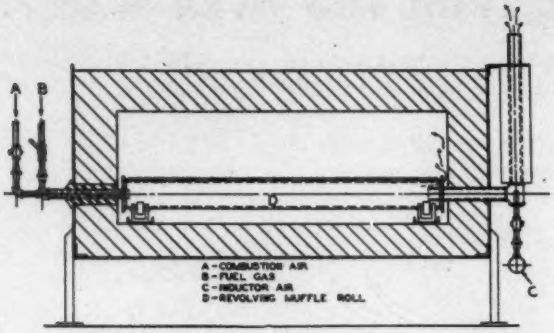
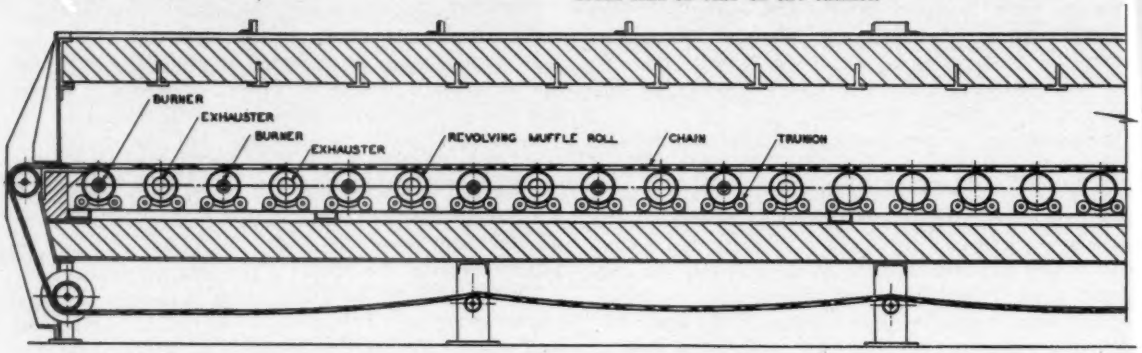


Fig. 2. Diagrammatic cross-section showing trunnion-mounted tubular lehr belt roller, together with piping for burner and exhauster.

Fig. 3. Diagrammatic longitudinal section of the new Dunbar lehr, showing arrangement of burners and exhausters in the first twelve rollers to maintain uniform temperature from side to side of the tunnel.



the first twelve rollers are fitted with burners, the six nearest the charging end being under the influence of the automatic temperature control system and the others being manually adjusted as a unit. The manually adjusted burners ordinarily consume little fuel and simply control the length of the heating zone, as required by operating conditions.

The thermocouple nearest the front end of the heating zone provides the temperature indication for automatic control of the burners. It is connected to a Brown pyrometer of the indicating type which, in turn, controls the master air and gas valves through a Minneapolis-Honeywell motor-operated apparatus. Four other couples are installed at intervals through the lehr tunnel, a convenient switch being arranged so that any single one can be connected to the pyrometer for a reading at that point. When the switch is released the connection between the first couple and the pyrometer is renewed instantly and automatic temperature control of the burners continues.

The overall length of the "Firoll" lehr at Dunbar Glass is 75 ft., including a 60-ft. tunnel and a 15-ft. open section at the discharge end, as shown in Fig. 4. The last 10-ft. length of the tunnel is uninsulated and has adjustable louvres in the top, but the remainder of the tunnel is lined with insulating refractory 4½ in. thick and part of it has an additional 4½-in. layer of Verimculite insulation. Vent stacks are installed at intervals to established and maintain any desired rate of cooling. The casing is built of structural steel and plate.

The lehr belt is of the Cambridge wire-mesh type and is 6 ft. wide. The distance from the belt to the top of the tunnel is 15 in., the belt being located 10½ in. above the bottom of the tunnel and 34½ in. above floor level. The 18-in. rubber-covered driving roller for the belt is located at the discharge end and is driven by a 3-hp. motor through a Reeves variable-speed transmission, a double-reduction worm-gear speed reducer, sprockets and chain. The belt-carrying tubular rollers are 6 in. in diameter, inside. The burner rollers are made of Duraloy, the others being manufactured from standard pipe. Trunnion rollers are of alloy steel in the heating zone and cast iron elsewhere, with alloy-steel pins throughout.

At Dunbar Glass oven ware is annealed with the new lehr at 1,240°F. on a 45-minute cycle and the results have so far been very satisfactory. Although the "Firoll" heating system has a total of twelve burners, the fuel economy seems to be excellent and the automatic control holds the temperature in the heating zone within a very small range. Furthermore, it has been possible to secure and maintain a temperature gradient close to the theoretical, with ample time at the annealing temperature and no short peaks.

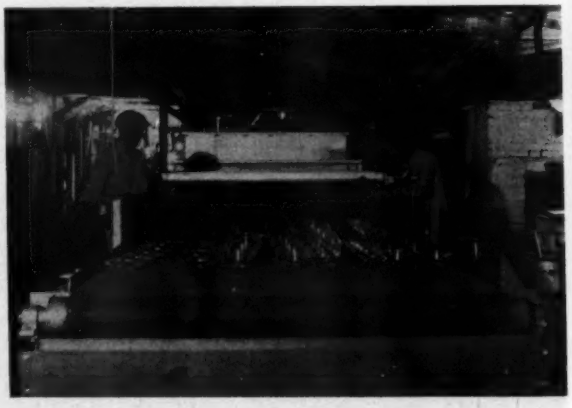


Fig. 4. Discharge end of the new lehr, showing the 15-ft. open section and delivery of annealed ware on the wire-mesh belt.

HOW TO MEASURE ACCURATELY THE TEMPERATURE OF A FLOWING GAS

Use of ordinary thermocouples in the gas stream introduces errors that can be largely obviated by couples with very small diameter, or by using suction type couples.

When determining heat balances on regenerative and recuperative furnaces or when comparing the efficiency of various checker designs by actual test, it is necessary that the temperatures of the gas or air streams flowing through the checkers, recuperators, flues and stack, be determined with a fair degree of accuracy. Although it is becoming generally understood that accurate measurement of the temperature of flowing gases under these conditions is by no means an easy matter, a quite usual method is to insert a thermometer or thermocouple into the gas stream, taking the indicated temperature as the true temperature of the gas. Such a reading, however, may be seriously in error, because the flow of heat by radiation between the measuring device and its surroundings affects the indicated temperature quite radically.

The tremendous effect of such radiation has been shown by the experiments of R. T. Haslam and E. L. Chappell.[1] Air, with a true temperature of 270° F., was blown through a short section of red-hot pipe, in the center of which the thermocouple was located. The velocity of the air was 6.0 ft. per sec. and the temperature of the pipe was 1,350° F. As measured by the thermocouple, the apparent temperature of the flowing air was found to be 890° F., so the reading was 620 degrees higher than the true gas temperature. The reason for the great difference between the apparent and true temperatures becomes obvious when it is considered that the thermocouple receives heat both by radiation from the walls of the chamber and by conduction from the flowing gas.

Greater difficulty is encountered in measuring the true temperature when there is a substantial difference between the temperature of the flowing gas and the temperature of the surroundings. When the surroundings are at a lower temperature than the gas, the thermocouple will radiate heat to them, indicating a temperature lower than the temperature of the gas; but the reverse is true when the gas is at a lower temperature than that of the surroundings. Then the thermocouple will receive radiant heat, the indicated temperature will be higher than the true gas temperature and will approach the temperature of the surroundings.

Due to this radiation effect, therefore, the temperature indicated by a thermocouple in a stream of flowing gas will always lie between the temperature of the gas and the temperature of the surroundings. To obtain the true gas temperature the radiation effect must be reduced to a minimum and several methods have been devised to accomplish such reduction.

The apparent temperature will be brought closer to the true temperature if the rate of heat transfer by conduction is increased, and this may be accomplished by using a couple made of very small wire and with a small bead at the junction. The rate of heat conduction per unit area is greater for a small wire, while the heat transferred by radiation is proportional to the amount of surface. The effect of couple size is shown by the following table, in which the results are based on work by Kreisinger and Barkley[2]:

Diameter of couple in in.	*Temp. at Position A in deg. F.*	*Temp. at Position B in deg. F.*
0.008	1,780	1,670
0.450	1,550	1,270
Temp. diff.	230	400

From the above figures it can be shown that the approximate error introduced by the use of a very small couple is about 10 per cent. With an 0.008-in. couple an apparent temperature of 1,780° F. was obtained, while the true gas temperature was 1,840° F. However, the main disadvantage in using a very small couple is that it is extremely fragile and corrodes very easily. The smallest practical sizes give an appreciable error, because their diameters are well over $\frac{1}{10}$ of an inch.

The results obtained by Kreisinger and Barkley led them to assume that thermocouples made of infinitely

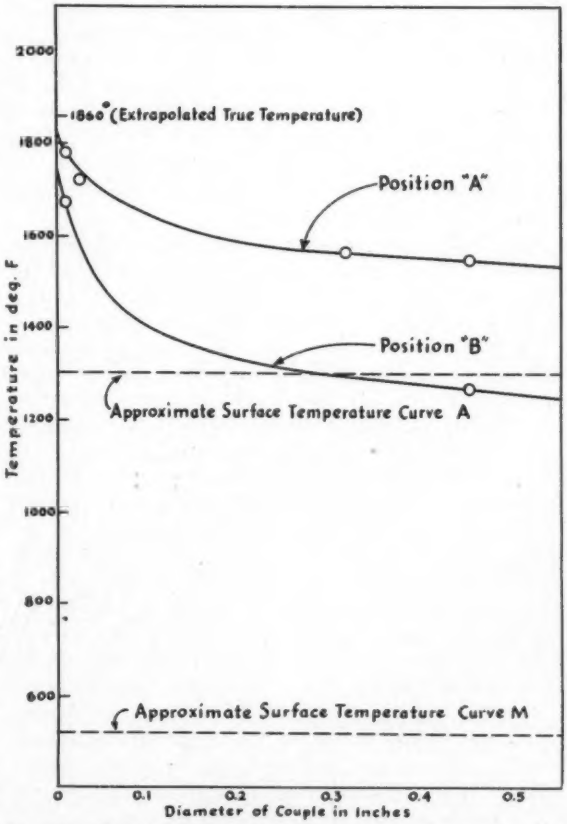
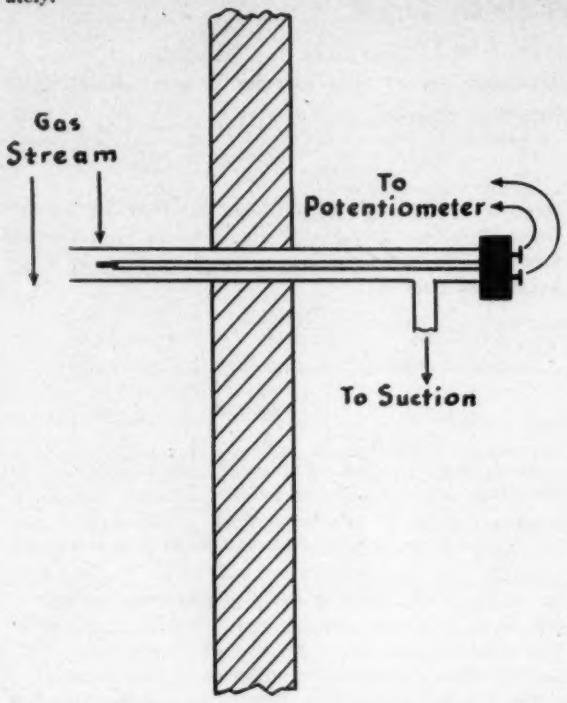


Fig. 1. Method for obtaining true gas temperature by extrapolation (Kreisinger and Barkley).

Fig. 2. Diagrammatic application of suction thermocouple for measuring temperature of flowing gas accurately.



thin wires would record true gas temperatures. They then used a cluster of couples, with diameters ranging from 0.01 to 0.5 inch, took simultaneous readings on all and plotted the indicated temperatures against the diameter of the wire. Extrapolation of the resulting curve to zero diameter gives a fairly accurate value of the true gas temperature, and this method is illustrated in Fig. 1. The extrapolated value is 1,860° F. against the true value of 1,840°, an error of only 4 per cent, but the disadvantage of the method is in the use of several fragile couples of small diameter.

By far the most satisfactory method yet devised for measuring the temperatures of flowing gases accurately seems to be the use of the high-velocity, or suction thermocouple. In its simplest form this device consists of a small thermocouple surrounded by an open-end quartz or porcelain tube with a suction connection, as shown in Fig. 2. The couple and its surrounding tube are inserted in the gas stream and a rapid current of gas is drawn out through the tube. The high velocity of the gas in the tube greatly increases the rate of conduction, both the inner surface of the tube and the junction of the thermocouple rapidly approaching the actual gas temperature. The gain or loss of heat through radiation is slight, because the tip of the thermocouple is surrounded by surfaces that are practically at the true gas temperature. Although it is not necessary to consider the temperature of the surroundings nor the velocity of the gas stream into which the tube is inserted, accurate results can be obtained with the suction thermocouple only if the velocity of the gas flowing through the tube is around 20 ft. per sec., and the error can be still further reduced by increasing the velocity further.

[1]Ind. Eng. Chem., 1925, 17, 402.
[2]Bull. U. S. Bureau of Mines, No. 145, 1918.
[3]J. S. G. T., 1932, 63, 315.

As an example of the results that can be obtained through the use of the suction-type thermocouple, some of the data secured by M. Parkin and F. Winks[3] are given:

Time after reversal in min.	*Temp. by ordinary Couple (deg. F.)*	*Temp. by Suction Couple (deg. F.)*	*Diff'ence*	*Remarks*
		Air Regenerator Temperatures		
8	1,445	1,490	+45	Waste gas
16	1,508	1,580	+72	" "
10	1,346	1,175	—171	Air
30	1,256	1,058	—198	"
		Air Valve Temperatures		
10	743	761	+18	Waste gas
27	779	805	+27	" "
		Stack Flue Temperatures		
	905	941	+36	
	932	968	+36	
	968	1,004	+36	
	1,004	1,031	+27	

These results show very clearly the magnitude of the error introduced by the use of the ordinary type of thermocouple. At higher temperatures, such as are encountered near the downtakes and top checker courses, the error would be much larger. The one disadvantage of the suction thermocouple is the necessity for equipment to produce the suction through the tube. Parkin and Winks found that a small vacuum cleaner gave very satisfactory results, while the suction-type device designed by Siemens and Halske incorporates a combination steam or air ejector as an integral part of the apparatus.

MICROPROJECTION METHOD FOR DETERMINING GRAIN SIZE OF OPTICAL ABRASIVES

Dr. Frank L. Jones, holder of a Bausch & Lomb Fellowship at the Mellon Institute of Industrial Research, has recently published his paper on "Determination of the Size of Fine Abrasive Powders," in which he describes a new method for setting up standard specifications for the natural corundum abrasives produced for use in the optical industry. Dr. Jones has developed a microprojection method for determining size-distribution curves that may be used in controlling plant production of corundum for optical grinding. The author describes the apparatus used and the method of preparing slides for examination.

Dr. Jones cites the advantages of the microprojection method, for determining size-distribution curves in controlling plant production of corundum in the optical industry, as being due to the fact that many of the samples are below 10 microns in average particle size, in which range the grading is close, only a few particle sizes are found in a sample, and the number of particles to be measured to obtain a size-distribution curve is low. Results are reproducible within 1 micron for plant samples.

The time needed to prepare the sample, measure the grains, and compute the accumulation curve is less than 2 hours. There is no uncertainty about the quality of a reagent, such as the methanol used in the sedimentation method, nor about the dispersion of the grains in the liquid. No more skill and care in manipulation is required for a microscopical determination than by the sedimentation method.

OVERSELLING A CASE

By PAUL EMIC

The touching tale of Elmer, the laboratory boy who was expected to be beaker boy, petrographer, and doubtless general utility man as well, which that eminent exponent of popular science, Prof. Adam D. Bunker, contributed to the September issue of THE GLASS INDUSTRY prompts me to reply in Elmer's behalf. I realize fully that this is essentially a quixotic effort and that I lay myself open to a charge of tilting at windmills; but, as Prof. Bunker is about the windiest mill I have ever encountered, I am willing to take what risk there is on the ground that there can be no better sport than tilting at such an opponent.

To begin with, the story of Elmer is written with such feeling and intensity that one can hardly escape the conclusion that Prof. Bunker is drawing on personal observation, perhaps is even being autobiographical. This being the case, I am willing to admit without question that the facts are as set forth by him and I shall assume that the situations described by him are skimmed from the richness of his experience. The conclusions which he draws from these facts and situations are, however, another matter; for his reasoning is acidophilous and the skimmings turn sour.

The primary fallacy in his reasoning, which is best described as mineralogic rather than logic, is that he condemns an exceedingly useful research instrument: namely, the petrographic microscope, merely because one poor laboratory boy got into difficulty. Such a generalization from a single case is quite unworthy of a man of his attainments. Does he condemn the telescope because a blind man cannot use it? Does he condemn the telephone because a deaf person might not find it useful? Then why does he condemn the polarizing microscope because it is not suitable for use by the dumb?

The root of this curious thinking seems to be in a lack of faith in the results ordinarily obtained with this instrument; but he cautiously refrains from pressing this point, which would reveal him to the world as a Tory—a mineralogic royalist! For his argument takes us directly back to the horse-and-buggy days of mineralogy. It is difficult to find an explanation for so reactionary an attitude, but I think one can be found on psychological grounds. It is now well established that human beings instinctively distrust what they do not understand, and it is entirely reasonable to suppose that Prof. Bunker's feeling is based on his obvious lack of comprehension of the proper use of the microscope.

He further implies that Elmer was purposely deceiving his employer; that he was, so to speak, pulling the glass wool over his eyes. This is certainly deliberate misrepresentation, because Prof. Bunker knows, as well as he knows anything, that Elmer is not malicious but merely ignorant and placed by circumstances at least partially beyond his control in a position for which he is totally unfitted. Now whose fault is that?

A large share of the blame clearly falls to the boss who should have known better than to put a laboratory boy at such work. If the boss is so painfully lacking in experience and foresight, can one logically blame Elmer for the same deficiency? The boss, or as he likes to be called, the executive, is paid for picking men and if he fails, why blame Elmer?

Moreover, were the boss a true believer in the more abundant life he would not hire a forlorn Bachelor of Engineering to do everything but he would be willing to pay enough to attract a competent man to each special job. With a proper man, he can get most useful and trustworthy information, if he is willing to pay for it (Advt.). When the best of all possible worlds is achieved this situation will be corrected, because the Ancient Honorable Independent Amalgamated Union of Mineralogists and Petrographers will not permit such a job to be filled by a boy with so little training.

But the boss is not the only party at fault. A large part of the blame for Elmer's difficulties should go to those who gave him what training he did have. The boss probably took some professor's word for it that Elmer was a finished product and never thought to ask whether he had a dull finish or a bright finish. Perhaps the professor wouldn't have known if he had been asked. At any rate, the fact remains that in this case, as in many others, the boss who asked for bread was given a stone. The array of fancy interference figures which were supposedly one of the strongest points in Elmer's bag of tricks turned out finally to be nothing but a double cross. But why blame Elmer? Or why place all the blame on the boss? Why not carry some of it back where it belongs—to our colleges, which make a grand ballyhoo about knowledge being power, but always forget that a little knowledge may be, and usually is, a dangerous thing. So they go on exposing students to a set of four lectures on the petrographic microscope sandwiched in betweeen a similar set on the Phase Rule and another on pyrometry? The results of this system are well illustrated by a recent conversation with one of Elmer's colleagues. When asked whether he had read what Winchell said on a certain mineral he replied that he never read Winchell because he thought he was better over the radio!

The situation which Prof. Bunker deplores arises, therefore, through no fault in petrography, but rather from an economic and an educational system which makes it necessary for an instrument manufacturer to strive to make his instruments not only fool-proof but college-graduate proof as well.

Prof. Bunker has tried to disparage the polarizing microscope by directing attention to a number of things it can not do. In order to keep the record straight I should like to point out a few things it can do. In the first place, it proved to be an excellent indirect means of revealing the sawdust stuffing which fills the shirt of Elmer's boss. But it has other more scholarly and scientific claims for merit. What other tool can one use to determine the size, shape and distribution of pores in a refractory? What other can one use to determine the nature and amount of the several forms of silica present

in fired siliceous products? What other can one use to be certain of twins? Until such time as Prof. Bunker has a satisfactory alternative way of doing all these things let him restrain his criticism.

In conclusion, I think some tribute is due to those true and skillful petrographers, whom I like to call the Knights of the Nichol, and I should therefore like to mention their triumph in the study of Gesundhite, an amber-colored liquid phase, widely distributed geographically, good specimen sof which are highly prized by collectors. It is best studied in quartz, although lesser occurrences are often acceptable. In the old days, sometimes called the good old days (although I believe the classification has not been fully accepted by geologists for use on their time scale) it required but one nichol to study even the best samples, but it has been conclusively shown by tests by Hundert and by Tausend, that in these modern times at least two nichols are required for a sample worth spending any time on.

GLASS NEWS FROM THE PACIFIC COAST

While there have been no spectacular developments in the glass business in California, all reports indicate that business has continued to improve throughout the summer. The three flint glass plants, Crystalite in Glendale, Technical in Los Angeles and Brock Glass Co. in Santa Ana, are all working at near capacity.

The Maywood Glass Co. has operated at capacity through the year, except for the usual repairs. They have added two ware lift trucks to their warehouse equipment. Cullet crushing, storage and handling equipment have been installed. A new steel warehouse has been built as well as two temporary warehouses which will soon be replaced by a steel building having approximately 15,000 sq. ft. of floor space.

The Latchford Glass Co. is operating their three furnaces on machine ware with an occasional machine down. They have rebuilt their tanks to new designs to increase their melting capacity and give a better quality product.

The Owens-Illinois Glass Co. has practically enclosed their original plant with new bulidings of glass brick and concrete construction.

OPTICAL GLASS CATALOG

The results of many years of research, experiment and development by the Bausch & Lomb Optical Co. in the field of optical glass production is now being made available to the optical industry generally in a recently published optical glass catalog. This company engaged in the regular production of optical glass at the time when most good glass of this nature was imported and because, as a large user of all varieties, a dependable source of supply was of vital importance. Large-scale operation has made possible extensive chemical and physical research and the application of refinements and improvements in manufacturing procedures.

More than a dozen types of glasses are listed in the new catalog, all of these being reproducible within reasonable limits and in regular production. The B & L glasses can be supplied in square or rectangular plates or in the shape of pressed or moulded blanks. A reasonable stock of listed sizes is carried, but processing time may extend over several months under certain conditions.

Another recent publication of Bausch & Lomb is a 16-page catalog, No. D-16, which illustrates microtones and accessories. These instruments are used to make thin sections of materials for microscopic examination.

LECTURES ON NEW DEVELOPMENTS

Dr. Alexander Silverman, head of the Department of Chemistry of the University of Pittsburgh, recently delivered two lectures on the newer developments in glass before the Western New York section of the American Ceramic Society and the North Eastern Ohio Teachers' Association. Dr. Silverman covered developmpents in tempered glass, fiber glass, glass for structural purposes and recent developments in illuminating glass ware and optical glass.

In connection with optical glass, Dr. Fred Y. Herron, also of the University of Pittsburgh, gave experimental demonstrations on the absorption of infra-red and the transmission of ultra-violet, showing effects produced by the latter on various substances, including glasses, through the use of a mercury vapor lamp enclosed in a nickel glass tube.

BIGGERS SEES UPTURN

John D. Biggers, president, Libbey-Owens-Ford Glass Co., in a letter to stockholders, reported a substantial improvement in business during August and September and predicted a favorable fourth quarter. The steady increase in activity in the building industry has contributed to increased sales in window glass, polished plate glass and Vitrolite structural glass. In the motor industry, as well, improved conditions have stimulated sales of safety glass. One important result of this increased activity was the return of some 1,700 employees to the company's payrolls in its various plants.

SMOKE THROUGH GLASS

Lederer, Ross Co., New York City, have developed a new cigar and cigarette holder equipped with a filter consisting of a series of mesh wire which encloses dividers of woven glass cloth. The glass cloth, which is non-absorbent, filters the resinous acids from the smoke, such as tobacco tar and creosote. The filters may be cleaned with hot water. The holders themselves are made of Bakelite cast resinoids in a variety of colors.

NEW SELF-CONTAINED LIGHTING UNIT

Combining within a single sealed unit, for the first time in lighting history, all the elements necessary for the production of controlled light, a lamp designed for a multitude of indoor and outdoor projection and floodlighting applications has been developed by the Incandescent Lamp Division of the General Electric Co., Nela Park, Cleveland. This projector lamp embodies a precisely-pressed glass reflector and a light-re-directing cover lens as part of a funnel-shaped glass bulb. It is available with two types of cover lenses, one giving a wide-spread beam and the other a powerful narrow beam.

● Advertiser interested in SPUN GLASS FIBRES for insulalation and textile purposes would consider manufacture under license or otherwise. Send particulars in first instance to Derick R. Martin, 5, Theobalds Road, London W. C. 1, England.

GLASS NEWS FROM ABROAD

Entirely apart from its general significance in so far as world peace is concerned, the annexation of the Sudetenland from Czechoslovakia by Germany has a particular interest to American glass men. For some time back there has been discussion and speculation as to the long-time effect which the reciprocal tariff treaty with Czechoslovakia would have on the American glass business.

What, if any, effect will Herr Hitler's seizure of the Sudetenland have on the Czechoslovakian glass industry? Through the courtesy of the United States Department of Commerce, THE GLASS INDUSTRY is privileged to publish on this page a map which indicates clearly that most of the Czechoslovakian glass plants are located in the Sudetenland which is rich in raw materials and power. Just what percentage of the glass is produced in this territory is not known accurately, however, it is safe to assume that most of it comes from this section. For example, the production of Gablonz ware is centered around Gablonz and undoubtedly American imports of these items will be affected.

The chief significance of the Sudeten annexation, in so far as American glass men are concerned, lies in the fact that Czechoslovakia, by virtue of reciprocal tariff agreements with the United States, enjoys an extremely low tariff rate on exports of glassware to the United States. Germany, on the other hand, has no such agreement with the United States and must pay the full tariff rate.

The question of whether the Sudetens, now that they are Germans and not Czechs, will have to pay a higher tariff is still a matter of diplomatic negotiation and what the outcome will be is not known. Several American companies, recognized as large scale importers of Czechoslovakian ware have sent their own investigators to the Sudeten area in an effort to secure first hand information on the entire situation.

Another extremely important factor is the question of wages paid to workmen. American glass men have frequently complained that due to the low wages paid Czech workmen they were unable to compete with Czechoslovakian glass on a price basis. It is reported that the minimum wage rates applying to German workers are some three times higher than those paid to Czech workers. If Hitler decides to raise the standard of pay of the Sudeten workers to equal that of German workers, it would probably mean an increase in the price to be paid for glassware from that territory. But here again, Herr Hitler has not make known his decision.

Disregarding reports in newspapers about the emigration of Czech workers and plants from the Sudetenland, it would seem that the annexation of this territory by Germany should be helpful to the question of competition from Czech glassware—from the point of view of the American glass industry, of course.

Bulgaria: The industry in Bulgaria* is a relatively young one, the first glass manufacturing plant having been established just prior to the World War, in the village of Gebedje, near the port of Varna, on the Black Sea. The trading and exchange difficulties so common in Central Europe during the past decade proved a stimulant to the development of local industries for supplying the needs of the domestic market and this tendency was reflected in the glass industry. Three plants are now in operation: Gebedje for blown and window glass, Pernik for window glass only, and Sofia for blown glass only. Practically, the entire output is for the local market, there being no exports of importance.

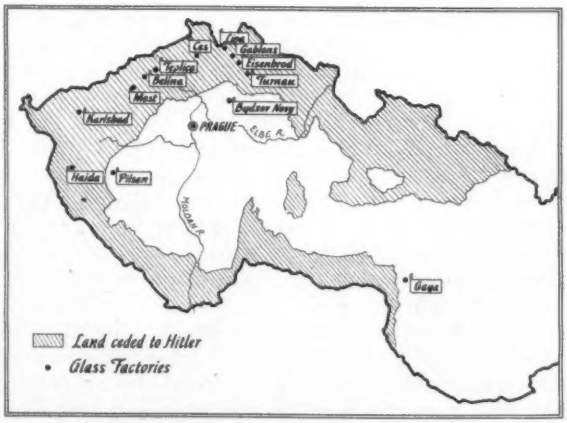
Bulgaria is rich in raw materials for making glass, such as sand, lime, kaolin, etc. The imported materials are mainly sodium, potash and some other chemicals, not to mention gasoline, gasoil, and lubricants. The technical equipment is reported to be thoroughly modern, since new machinery was introduced in 1933.

The prospects for the sale of American glass products are not very encouraging, in view of the distance separating the two countries, while the main competitors Germany, Czechoslovakia and Belgium are able to make rapid and cheap deliveries. Furthermore, even these countries are gradually being excluded from the Bulgarian market with the expansion of the local glass industry, especially for trade in window glass, bottles and ordinary glassware. This is strikingly shown in the listing of imports of glass products from 1929 to 1936. Imports of window glass, for example, dropped from 4,507,000 kilograms in 1929 to 1,087,000 in 1936 and the estimates for 1937 are placed at only some 300,000 kilograms. An increase in imports is shown only in finely worked or special glass products which are not a specialty of the local plants, such as vases and containers for pharmacies and laboratories, finely worked glass products, vases and others, engraved or polished, and finely ornamented window glass and plates, etc. However, the purchasing power of the Bulgarian does not permit of much expansion of the so-called luxury trades.

*From a report to the U. S. Department of Commerce by Consul Cavendish W. Cannon, Sofia.

PROFESSOR TURNER TO VISIT U. S.

Professor W. E. S. Turner, honorary secretary of the Society of Glass Technology (England) and one of the world's most prominent glass technologists, plans to visit the United States and Canada during the next two months. He will land in Montreal on Oct. 29 and make his way through the Middle West, returning through Columbus and sailing from New York for England on Dec. 10.



Glass plants located in Sudetenland.

BOOK REVIEWS

• **Glass in Architecture and Decoration,** by Raymond McGrath and A. C. Frost, together with H. E. Beckett. The Architectural Press, London, 1937. pp. 664, £3-3-0.

This book measures 12¾″ x 9½″ x 2″, is printed on heavily glazed paper, and weighs 7¾ lb. It should properly be sold with a tea-wagon to carry it around. It contains 371 figures in the form of plates, and a number of others in the text. Short of the Harmsworth Atlas, the Encyclopedia Britannica, and the Architects' Catalogues this is physically the most awkward book the reader is likely to encounter in many years of industrious reading. Its disabilities, however, are entirely physical, for so far as mental contents go, the book is excellent.

It is probable that no single reviewer can properly appraise this book; to do so he would have to be both a glass technologist and an architect. The present reviewer, having begun life in the building industries, and having become a glass technologist by accident, attempts it with an uneasy conscience.

It should be observed, to begin with, that this is a collaborative work. Two authors' names appear on the cover; on the title page, the authors increase to three; and in the preface, (p. x) it is acknowledged that there are four, the fourth being C. J. Morreau, who like H. E. Beckett, is of the Building Research Station. The reviewer would scarcely scruple to make them five, for the influence of W. M. Hampton seems in a good many places to be both extensive and direct. Who then am I to comment on such a galaxy of talent?

It seems easiest to begin in the middle and work towards both ends. This enables us to begin with glass and finish with architecture, attacking the relevant glass technology and physics first, and coming round to its application in architecture later.

The title of the book virtually calls for this order, for its title is "Glass" (in Architecture) but the theme of McGrath and Frost is "Architecture" (in Glass). They take as their slogan the contention of Le Corbusier, that "The history of Architecture is the history of the Struggle for a Window," and since there has not yet been found, and is never likely to be found, any adequate daylighting substance other than glass, it follows that the history of Architecture is the story of a long struggle to get along first without glass, then with inadequate amounts of glass, and finally with glass of inadequate properties, particularly inadequate mechanical strength, but also inadequate optical qualities.

It appears that glass is the ideal substance for architectural purposes, and all other materials like wood, stone, concrete, and perhaps steel are merely temporary expedients and ersatz make-shifts, until such time as the glass technologist and glass manufacturer can bring their craft to perfection and provide the architect with a really worth-while medium.

Glass does not burn up like wood at the slightest provocation, nor is it eaten by termites; it does not rust like steel, disintegrate like most concrete, or suck up water like most stone. It does not run away with heat like steel, for its thermal conductivity is low; and in the form of hollow blocks it is far better than solid clay and stone in this respect. It is chemically more durable than any other available material, and it lends itself to more situations, adopting more colors, more surface treatments, and more forms than any other substance.

So on page 413 Beckett and Morreau begin with a well-thought-out analysis of those physical properties of glass that concern the builder. This section all told is only about 100 pages long, but it is probably the most useful survey of this field that we have to date. As an orientation course for architects it could scarcely be improved on, and there are many glass technologists who might do well to read it carefully.

This section covers not only such topics as mechanical strength, but also the behavior of glass structures in sound-proofing, a matter of increasing importance. It deals also with the transmission of light, infra red radiation, and ultra violet, in a very clear fashion, and with some of the complexities of glass and concrete (*béton translucide*) and glass brick construction.

From this central section we may go either forward or backward. In each case we come to a section dealing with the making or working of glass. In general the earlier section discusses those operations upon glass that take place normally in the manufacturers' plants, while the latter section deals with those that commonly take place to the specification of the architect; but the distinction is not rigid, and physically there is not always any significant difference. After all, what can be done to glass is settled mainly by the nature of glass itself.

Having now discovered what glass is, how it can be made and worked, we need to know next the history of the discovery or invention of these matters, because, according to the thesis of the authors, this settles what architecture has been like throughout the centuries. So the book begins with some 80 pages on the making of glass, and continues with 200 more on the history of architecture as a Struggle for a Window.

All of this is excellent. The pages on the manufacture of glass are open to very little criticism. The authors either know a great deal more about glass making than most architects or they got much better help than ordinary. In fact, they have come nearer the truth in many cases than the current text-books of glass technology, so maybe the schools had better throw out their text-books and adopt McGrath and Frost.

The pages on the history of architecture are good also: the modern revolt from the elaborate and vacant-minded "art" of the nineteenth century to the severly functional art of the present day, is almost wholly good in the authors' eyes. The present reviewer, for the benefit of young architects, would like to enter a *caveat*. Not all the frills of the old style architecture were functionless. Cornices may be rain drips as well as exercises in ogee curves; driving rain as well as vertical down-pours must be dealt with, and the more impervious the wall or the more extensive the windows, the greater the flood of water that will pour over sills in unit time. There are lots of pitfalls in the thermal expansion properties of

(*Continued on page* 431)

EQUIPMENT AND SUPPLIES

CATALOGS RECEIVED

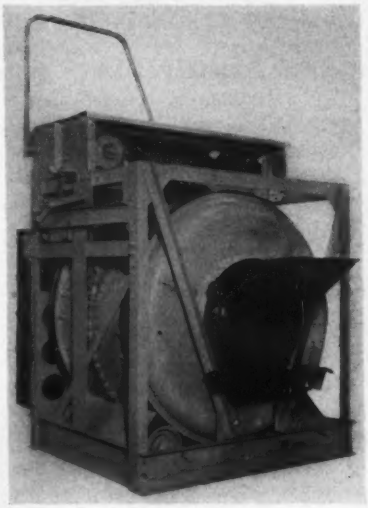
Askania Regulator Co., 1603 S. Michigan Ave., Chicago, Ill., have recently published a most informative bulletin, "Automatic Control for Steam Generating Units." Starting with a discussion of fundamental problems of boiler control, the booklet describes the part played by Askania equipment in such control.

Chain Belt Company, Milwaukee. Catalog No. 333 is a well-illustrated book of 128 pages, giving complete descriptive and engineering data on Rex roller chains and sprockets. The catalog covers chains and sprockets for high-speed power transmission, as well as for materials-handling applications. The equipment is available in standard and non-standard series and also with a variety of attachments.

CLEVELAND TRAMRAIL TRACTOR

For pulling or pushing buckets, racks, etc., over its tramrail systems, Cleveland Tramrail, Division of Cleveland Crane & Engineering Co., Wickliffe, Ohio, is now producing an improved tractor unit. As shown in the accompanying illustration, the unit consists of a suitable frame which hangs on four carrier wheels and supports the driving motor. The motor shaft is geared to driving wheels which make contact with the under side of the rail, these wheels being mounted in spring-pressed yokes which hold them tightly against the rail.

This unit is adapted for floor, remote or pulpit control, current being supplied to the motor through two-wheel current collectors. Although only 32 in. long overall, the tractor unit has a rated drawbar pull of 750 lb. When handling batch buckets in a glass plant installation, this tractive effort is sufficient to handle a load of 10 tons, or more, on comparatively level track. The spring-pressed rollers also make the unit adaptable for hauling lighter loads on systems having comparatively steep grades. The available speed arrangements vary from 2 to 150 ft. per min.

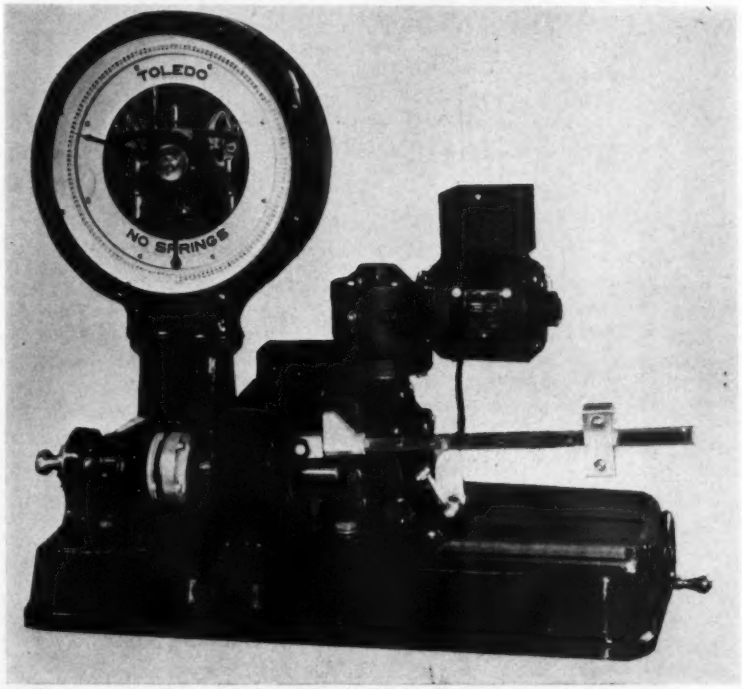


REX GLASS BATCH MIXER

An improved Rex glass batch mixer, especially designed for fast and thorough mixing action, has recently been introduced by the Chain Belt Co., Milwaukee. The manufacturer states that with the improved mixer the mixing time can be reduced to the shortest period permitted by related operations, one installation having produced satisfactory mixes in three minutes.

The drum of the mixer is made of high-carbon steel and is lined with alloy-steel renewable liners to resist the severe abrasion usually caused by the batch. The mixer can be used for either wet or dry batches. For wet mixing a tank which measures the quantity of water to be used can be furnished.

To eliminate spillage, dust seals are provided at both the charging and discharging ends, all dust being confined to the mixer drum while mixing, charging or discharging. The machine can also be charged or discharged without stopping, thus making it particularly fitted for use in connection with other automatic weighing and handling equipment. It is stated that a recent application with automatic and remote control has proven entirely satisfactory.



The new Toledo Scale Co. machine for testing the breaking strength of molded plastic bottle and jar caps.

UNIVERSAL BEVEL GEAR

A variable-angle bevel-gear assembly for connecting reach rods, extension shafts, remote valve controls, etc., has recently been brought out by the Condenser Service & Engineering Co., Inc., Hoboken, N. J. The device consists of two cast steel housing sections hinged together and carrying stub shafts on which specially designed bevel gears are mounted. These gears operate at all shaft angles from 45 to 180 degrees and are made of steel, although other materials can be furnished if desired. The installation of the device is recommended where a minimum number of joints in a shaft as desired.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	43.00	46.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	....	....
Granulated	In bags, lb.	.0215	.027 -.0295
Powdered	In bags, lb.	.024	.0295-.032
Boric acid (H_3BO_3) granulated	In bags, lb.	.048	.054 - .0565
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite ($Na_3Al F_6$) Natural Greenland (Kryolith)	lb.	.0876	.08
Synthetic (Artificial)	lb.	.0825	.085
Feldspar—			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	30.00	....
In bags	ton	31.60	38.00-40.60
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.076	....
In 5 Ton lots	lb.	....	.08
Less than 5 Tons	lb.	....	.085
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	....
Burnt (CaO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	....
Burnt, ground, in 180 lb. drums	Per drum	1.60	1.70
Kiln Dried ($CaCO_3$) 10x30 mesh	ton	1.75	....
Kiln Dried ($CaCO_3$) 16x120 mesh	ton	1.75	....
Nepheline Syenite, f. o. b. shipping point	ton	14.50-17.00	....
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065	.0675
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4)	ton	15.00	25.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	.95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls	Per 100 lb.	....	2.50-2.90
95% and 97%			
Bulk	Per 100 lb.	1.35	....
200 lb. bags		1.415	1.44
100 lb. bags		1.45	1.475

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	....	.03½
Aluminum oxide (Al_2O_3)	lb.	.04	.07
Antimony oxide (Sb_2O_4)	lb.	.11½	.12¼
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03	.03½
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	.07¼
Pyrophyllite, (20% Al_2O_3)	ton	9.00	12.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.04¼	.05
Tin Oxide (SnO_2) in bbls	lb.	....	.48
Titanium Oxide (ceramic grade)			
In bags	lb.	.13¼	.13½-.14
In barrels	lb.	.13½	.13¾-.14¼
Zinc Oxide (ZnO)			
American process, Bags	lb.	.06¼	.06½
White Seal, 150 lb. bbls	lb.	.08¾	.09
Green Seal bags	lb.	.08	.08¼
Domestic White Seal bags	lb.	.08½	.08¾
Red Seal, bags	lb.	.07½	.07¾
Zircon			
Refined Granular (Milled .01-.02c higher)		.06½	.07-.08
Commercial, Gran. (Milled .02¼-.02½ higher)		.024	.029

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.40-1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	.85-.95
Chromite (99% through 200 mesh)	lb.	35.50	40.00
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls	lb.	....	.22-.26
Cobalt oxide (Co_3O_4)			
In bbls. 350 lbs. or more,	lb.	....	1.67
Less than 350 lbs.,	lb.	....	1.77
Copper oxide—			
Red (Cu_2O)	lb.	....	.185
Black (CuO)	lb.	....	.16½-.17½
Black prepared	lb.	....	.22
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.0425-.09
Black (Fe_3O_4)	lb.	.04½	.09
Iron Chromate	lb.	....	.035-.05
Lead Chromate ($PbCrO_4$) in bbls	lb.	....	.145
Manganese, Black Oxide			
In Paper bags	ton	54.50	57.50-62.50
In Burlap bags	ton	57.00	60.00-65.00
In Casks	ton	58.50	61.50-66.50
Neodymium oxalate, 50 lb. drums	lb.	....	3.50
Nickel oxide (Ni_2O_3), black	lb.	....	.35-.40
Nickel monoxide (NiO), green	lb.	....	.35-.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.08¾	.09-.09¼
Powdered	lb.	....	.09½-.09¾
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.2075-.2125
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¾	.07-.07¼
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	.08½	.08¾-.08⅞
Sodium selenite (Na_2SeO_3)	lb.	....	1.55-1.65.
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.75-1.80
Yellow	lb.	....	1.75-1.80
Sulphur (S)—			
Flowers, in bbls	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.65-2.75
Yellow orange	lb.	....	1.75-1.80

Polishing Materials

		Carlots	Less Carlots
Emery, Turkish	lb.	.063	.07
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	.03
0, 0½, ½, 1.	lb.	....	.03¼
Putty Powder	lb.	....	.38-.42
Rotten Stone, (Domestic)	lb.	....	.02
Rouge, Red	lb.	....	.14
Black	lb.	....	.16

(*Continued from page* 428)

glass facades facing the sun; and buildings can be struck by lightning if made of glass even as they can if made of brick.

The section on Glass in Decoration is probably the hardest to review. To no inconsiderable extent this battle has been fought on French soil, including therein French ocean liners. Beyond acknowledging frankly that he does not like the *Normandie*, glass decorations and all complete, and that, taken by-and-large, he would sooner have his back than his face towards the Pyrex decorations at Rockefeller Center, there is not much he can say on the subject.

Future generations will presumably laugh at our 1938 concept of Decoration, but I don't think they are going to laugh at the present trend in Architecture. In this there is clearly something vital. It has something to say, and it is beginning to succeed in saying it. It is natural and functional, and expresses the feeling of the age. It has possibilities. Those possibilities are at present largely circumscribed by the limitations placed on the architect by the glass manufacturer, who, in his turn, thinks he is limited by his material. This puts the whole matter squarely up to the glass technologist.—F. W. P.

• **The Glass Industry in Ohio.** Occupational Study No. 3 of the National Youth Administration in Ohio, Clinton Building, Columbus, Ohio. An 80-page illustrated, mimeographed book.

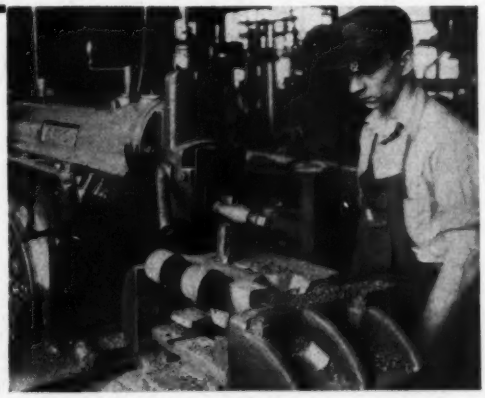
Opening with a short history of glass making, the book discusses the manufacture of hand-made glass and automatic pressed and blown ware. It also describes cutting, how plate glass is made, and the manufacture of light bulbs, fiber glass, mirrors, etc.

An appendix provides an occupational index, listing the approximate minimum wage and nature of the work in the 154 classifications.

The book was written by Simon N. Wilson, a cooperative student from Antioch College, who was employed by the National Youth Administration in Ohio as a research assistant. His work was supervised by Mrs. Katharine T. Patch, state supervisor of vocational guidance, and Miss Mary J. Drucker, assistant supervisor.

A 13-member committee read the manuscript and offered suggestions on arrangement and accuracy. Membership in this committee included management and labor executives in the glass industry, and the following: Dr. Mary H. S. Hayes, director of guidance and placement, National Youth Administration, Washington; Miss Mary Schauffler, vocational counselor, Western Reserve University, Cleveland; and Mr. Rowlee Steiner, personnel director, Anchor-Hocking Corp., Lancaster, Ohio.

One of a series of occupational studies on Ohio industries, the book was prepared for use by pupils in junior and senior high schools, and unemployed out-of-school youth.



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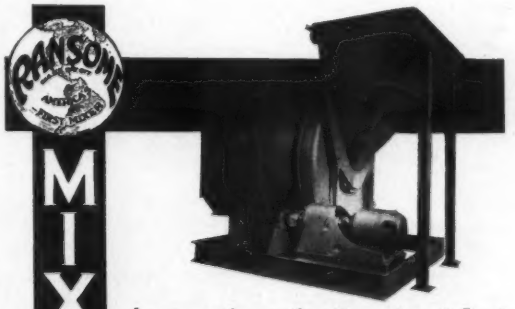

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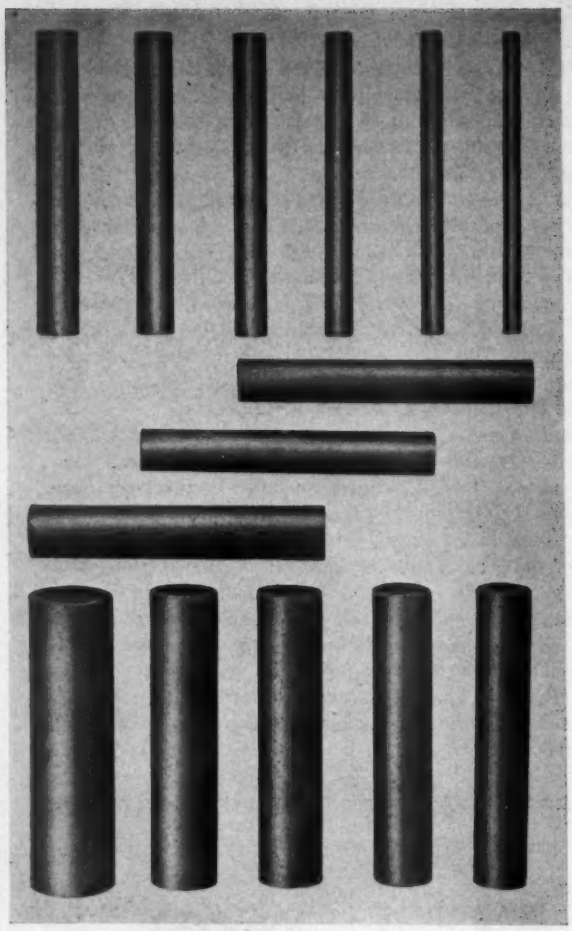

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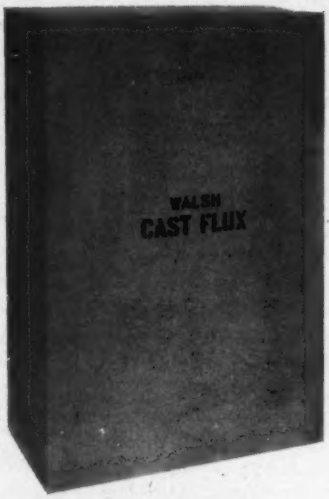

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF MARCH 3, 1933.

THE GLASS INDUSTRY, published monthly at 11 West 42nd Street, New York, N. Y., for October 1, 1938, State of New York, County of New York, ss:

Before me, a Notary Public in and for the State and County aforesaid, personally appeared John T. Ogden, who, having been duly sworn according to law, deposes and says that he is the Publisher of THE GLASS INDUSTRY and that the following is to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, John T. Ogden, 11 West 42nd Street, New York, N. Y.; Editor, John T. Ogden, 11 West 42nd Street, New York N. Y.; Managing Editor, John T. Ogden, 11 West 42nd Street, New York, N. Y.; Business Manager, John T. Ogden, 11 West 42nd Street, New York, N. Y.

2. That the owners are: Ogden-Watney Publishers, Inc., 11 West 42nd Street, New York, N. Y.; John T. Ogden, 11 West 42nd Street, New York, N. Y.; Dorothy Munsell Watney, 3207 N. E. 20th Avenue, Portland, Oregon; Katherine Waller Ogden, 1000 Park Avenue, New York, N. Y.

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Sworn to and subscribed before me this 30th day of September, 1938.

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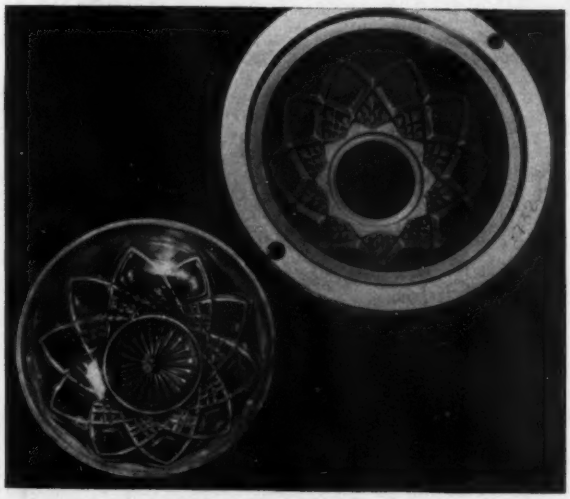

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